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Abstracts - Thesis Abstracts - Jobs - Meetings

From the Editor

The Active Galaxies Newsletter is produced monthly. The deadline for contributions is the last friday of the month. The Latex macros for submitting abstracts and dissertation abstracts are appended to each issue of the newsletter and are also available on the web page.
Matt Redman

Abstracts of recently accepted papers

Very cold dust in galaxies

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We present multi–filter far infrared photometry of *active* and *inactive* galaxies obtained with ISOPHOT. We find that the far infrared and submillimeter spectrum of the *active* galaxies can be described by a single modified black–body at a color temperature of 31.5 ± 2.8 K. The ratio of infrared luminosity to gas mass, $L_{\rm IR}/M_{\rm gas}$, where the latter quantity has been obtained from 1.3 mm observations within the central 11" is about $90\,{\rm L}_\odot/{\rm M}_\odot$. In contrast, the spectral energy distributions of *inactive* spirals require, apart from warm dust of 31.8 ± 2.8 K, an additional very cold component of at most 12.9 ± 1.7 K. Determining the gas mass from 1.3 mm dust continuum maps that cover the optical extent of the *inactive* spirals we find $L_{\rm IR}/M_{\rm gas} \sim 3\,{\rm L}_\odot/{\rm M}_\odot$, a factor ~ 30 lower than for the *active* galaxies.

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Starburst nuclei: ISO observations and models

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1.) We present photometric data of three starburst galaxies (Mkn 496, Mkn 1116, NGC 6000) obtained with the Infrared Space Observatory (ISO) in the wavelength bands 2.5–11.6μm (`P-40`) and 120–200μm (`P-22`). In all galaxies, we detect the 9.7μm silicate absorption feature and strong emission from PAHs; only the 3.3μm band is below the sensitivity limit of the instrument.
2.) We model the starbursts by computing the radiative transfer in the galactic nuclei under the assumption of spherical

symmetry. By properly adjusting the distribution of stars and dust, we can fit the observed infrared radiation, including the PAH features. The dust is described by a mixture of large grains, very small grains and PAHs, the latter all of the same size (25 carbon atoms). The photo–destruction of the PAHs is computed in a physically consistent way. *3.)* We explore the parameter space by modeling the spectral energy distribution of the ultraluminous starburst galaxy Arp 220. Although the nucleus is deeply hidden by dust, the simple radiative transfer calculations allow an estimate of its global structure.

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Resolved Spectroscopy of the Narrow-Line Region in NGC 1068. I. The Nature of the Continuum Emission

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We present the first long-slit spectra of the Seyfert 2 galaxy NGC 1068 obtained by the Space Telescope Imaging Spectrograph (STIS); the spectra cover the wavelength range 1150 – 10,270 Å at a spatial resolution of $0''.05$ – $0''.1$ and a spectral resolving power of $\lambda/\Delta\lambda \approx 1000$. In this first paper, we concentrate on the far-UV to near-IR continuum emission from the continuum "hot spot" and surrounding regions extending out to $\pm 6''.0$ ($\pm$432 pc) at a position angle of 202 degrees.

In addition to the broad emission lines detected by spectropolarimetry, the hot spot shows the "little blue bump" in the 2000 – 4000 Å range, which is due to Fe II and Balmer continuum emission. The continuum shape of the hot spot is indistinguishable from that of NGC 4151 and other Seyfert 1 galaxies. Thus, the hot spot is reflected emission from the hidden nucleus, due to electron scattering (as opposed to wavelength-dependent dust scattering). The hot spot is $\sim 0''.3$ in extent and accounts for 20% of the scattered light in the inner 500 pc.

We are able to deconvolve the extended continuum emission in this region into two components: electron-scattered light from the hidden nucleus (which dominates in the UV) and stellar light (which dominates in the optical and near-IR). The scattered light is heavily concentrated towards the hot spot, is stronger in the northeast, and is enhanced in regions of strong narrow-line emission. The stellar component is more extended, concentrated southwest of the hot spot, dominated by an old ($\geq 2 \times 10^9$ years) stellar population, and includes a nuclear stellar cluster which is $\sim$200 pc in extent.

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Resolved Spectroscopy of the Narrow-Line Region in NGC 1068. II. Physical Conditions Near the NGC 1068 "Hot-Spot"

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The physical conditions near the optical continuum peak ("hot spot") in the inner narrow line region (NLR) of the Seyfert 2 galaxy, NGC 1068, are examined using ultraviolet and optical spectra and photoionization models. The spectra were taken with the *Hubble Space Telescope*/Space Telescope Imaging Spectrograph (*HST*/STIS), through the $0''.1$X$52''.0$ slit, covering the full STIS 1200 Å to 10000 Å waveband, and are from a region that includes the hot spot, extending $0''.2$, or $\sim$ 14 pc (for H_0 = 75 km sec^{-1} Mpc^{-1}), in the cross-dispersion direction. The spectra show emission-lines from a wide range of ionization states for the most abundant elements, similar to archival Faint Object Spectrograph spectra of the same region. Perhaps the most striking feature of these spectra is the presence of strong coronal emission lines, including [S XII] λ7611 which has hitherto only been identified in spectra of the solar corona. There is an apparent correlation between ionization energy and velocity of the emission lines with respect to the systemic velocity of the host galaxy, with the coronal lines blueshifted, most other high excitation lines near systemic, and some of the low ionization lines redshifted. From the results of our modeling, we find that the emission-line gas is photoionized and consists of three principal components: 1) one in which most of the strong emission-lines, such as [O III] λ5007, [Ne V] λ3426, C IV λ1550, arise, 2) a more tenuous, highly ionized component, which is the source of the coronal-line emission, and 3) a component, which is not co-planar with the other two, in which the low ionization and neutral lines, such as [N II] λ6548 and [O I] λ6300, are formed. The first two components are directly ionized by the EUV-Xray continuum emitted by the central source, while the low ionization gas is ionized by a combination of highly absorbed continuum radiation and a small fraction of unabsorbed continuum scattered by free electrons associated with the hot spot. The combination of covering factor and Thomson optical depth of the high ionization components is insufficient to scatter the observed fraction of continuum radiation into our line-of-sight. Therefore, the scattering must occur in an additional component of hot plasma, which contributes little or no UV/optical line emission.

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BeppoSAX Observation of NGC 7582: Constraints on the X-ray absorber

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This paper presents a *BeppoSAX* observation of NGC 7582 made during 1998 November and an optical spectrum taken in 1998 October. The new X-ray data reveal a previously unknown hard X-ray component in NGC 7582, peaking close to 20 keV. Rapid variability is observed with correlated changes in the 5-10 and 13-60 keV bands indicating that a single continuum component, produced by the active nucleus, provides the dominant flux across both bands. Comparison between *RXTE* and *BeppoSAX* data reveals changes in the 2 – 10 keV flux on timescales of months. Changes in the nuclear X-ray flux appear unrelated to the gradual decline in optical flux noted since the high-state in 1998 July. The 0.5 – 2 keV flux of NGC 7582 is not significantly variable within the *BeppoSAX* observation, but has brightened by a factor of ~ 2 since the *ASCA* observation of 1994. While there is some concern about contamination from spatially-unresolved sources, the long-term variability in soft X-ray flux seems most likely associated with the nucleus or an event within the host galaxy of NGC 7582.

The 2 – 100 keV spectrum is well fit by a powerlaw of photon index $\Gamma = 1.95^{+0.09}_{-0.18}$, steeper by $\Delta\Gamma \simeq 0.40$ than the index during the 1994 *ASCA* observation. The X-ray continuum is attenuated by a thick absorber of $N_H \sim 1.6 \times 10^{24}\mathrm{cm}^{-2}$ covering $\sim 60^{+10}_{-14}$% of the nucleus plus a screen with $N_H \sim 1.4 \times 10^{23}\mathrm{cm}^{-2}$ covering the entire nucleus. Comparison of the *BeppoSAX* and *ASCA* spectra shows an increase in the full screen by $\Delta N_H \simeq 7 \times 10^{22}\mathrm{cm}^{-2}$ since 1994, confirming the absorption variability found by Xue et al. The increase in soft X-ray flux between 1994 and 1998 is consistent with the appearance of holes in the full screen allowing $\lesssim 1$% of the nuclear flux to escape, and producing some clear lines-of-sight to the broad-line-region. The data are also consistent with the scenario suggested by Aretxaga et al, of the radiative onset of a type IIn supernova causing the observed optical change in NGC 7582.

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A Kinematic Link between Boxy Bulges, Stellar Bars, and Nuclear Activity in NGC 3079 & NGC 4388

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We present direct kinematic evidence for bar streaming motions in two active galaxies with boxy stellar bulges. The Hawaii Imaging Fabry-Perot Interferometer was used on the Canada-France-Hawaii 3.6-m telescope and the University of Hawaii 2.2-m telescope to derive the two-dimensional velocity field of the line-emitting gas in the disks of the Sc galaxy NGC 3079 and the Sb galaxy NGC 4388. In contrast to previous work based on long-slit data, the detection of the bar potential from the Fabry-Perot data does not rely on the existence of inner Lindblad resonances or strong bar-induced shocks. Simple kinematic models which approximate the intrinsic gas orbits as nonintersecting, inclined elliptical annuli that conserve angular momentum characterize the observed velocity fields. In NGC 3079, bar streaming motions with moderately eccentric orbits ($e = b/a \sim 0.7$) aligned along PA = 130° intrinsic to the disk (PA = 97° on the sky) are detected out to $R_b = 3.6$ kpc. The orbits become increasingly circular beyond that radius ($e = 1$ at $R_d \approx 6$ kpc). The best model for NGC 4388 includes highly eccentric orbits ($e \sim 0.3$) for $R_b \leq 1.5$ kpc which are aligned along PA = 135° intrinsic to the disk (PA = 100° on the sky). The observed "spiral arms" are produced by having the orbits become increasingly circular from the ends of the bar to the edge of the disk ($R_d \approx 5$ kpc), and the intrinsic bar PA shifting from 135° to 90°.

Box-shaped bulges in both NGC 3079 and NGC 4388 are confirmed using new near-infrared images to reduce dust obscuration. Morphological analysis of starlight in these galaxies is combined with the gas kinematics derived from the Fabry-Perot spectra to test evolutionary models of stellar bars that involve transitory boxy bulges, and to quantify the importance of such bars in fueling active nuclei. Our data support the evolutionary bar models, but fail to prove convincingly that the stellar bars in NGC 3079 and NGC 4388 directly trigger or sustain the nuclear activity.

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UBVRI Light Curves of the Seyfert Galaxy NGC 7469 in 1990–1998: Microvariability

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Observations of the nuclear region of the Seyfert galaxy NGC 7469 obtained at Crimean Astrophysical Observatory with the 1.25m telescope are presented. During 64 nights on 9 observational runs between 1990 September 24 and 1998 October 22 in each spectral band of the *UBVRI* Johnson's system about 1500 measurements have been performed simultaneously through the round aperture 20 arcsec in diameter using differential photometry techniques. The estimated accuracy of each measurement is about $0.^{m}01$.

During the observing period 1990–1996 the mean luminosity of the nucleus was almost constant, only overlapping brightness fluctuations were observed. The mean luminosity level has been raised on October 1996. The peak amplitude (maximum flux/minimum flux) $F_{max}/F_{min} = 2.09$ on the light curves was observed in the U band, while the minimum amplitude F_{max}/F_{min}=1.32 was in the I band during all observation period.

Using Structure Function analysis, the following conclusions have been made:
1) long–term variability is caused by the same processes in the optical, because the slope "b" of the Structure Function (SF) is approximately equal for all wavebands. Only for the I band the slope is appreciably distinguished from the others. This would be an indication on the presence of independent IR energy source in NGC 7469;

2) considering the same time interval (from 6 minutes to 2 hours) for intranight variability on SFs at different wavebands, one can conclude that flicker noice causes variations observed on the light curve at the UV region (U and B bands), while at the near IR region the light curve is formed by mixed shot noice and flicker noice: the more wavelength, the more contribution of shot noice processes;

3) on intranight light curves of the NGC 7469 there exist rapid flares with durations $\sim$ 25 min at U band, $\sim$ 55 min at B, V bands, and $\sim$ 2 hours at R, I bands: a typical timescale of intranight variability increasing with the increasing wavelength.

In order to examine the intranight variations of the nucleus of NGC 7469, standard deviations (SD) of the nightly averaged flux F, and a measure of intranight variability – SD/F were calculated for each night of observations. The ratios P = N_i/N_{tot} of number of nights with SD/F $\geq$ 1%, $\geq$ 2%, $\geq$ 3%, and so forth, (N_i), to the all 64 observational nights, (N_{tot}), were expressed as a percentage of probability to detect variability at a given level; they were plotted versus the appropriate parameter SD/F. It is interesting that a probability to detect intranight variability at a level given by a parameter SD/F may be fitted well by "a probability curve" for a given galaxy. The homogeneity of data obtained with the same telescope using the same technique has made statistical comparisons possible among different galaxies and different wavebands. Therefore analogous curves for the Seyfert galaxies NGC 1275 and NGC 4151 were plotted, and were averaged by bands. Probability curves for the two galaxies of the same Seyfert type 1 (NGC 4151 and NGC 7469) coincided well. The probability curve for the galaxy NGC 1275 of a BL Lac type shows more nights with variations of amplitude less than 7%. The probability to observe intranight variations with an amplitude of more than 7% is approximately equal for both types of objects. An excess of nights with intranight variability parameter SD/F in the range of $\sim$ 4–8% is a common characteristics of two Sy1 galaxies (NGC 4151 and NGC 7469) and of a BL Lac object NGC 1275 studied in this paper. This excess may be connected with a specific type of intranight galaxy variability. All probability curves are fitted best by the exponential decay, second order.

As a result, one can conclude that intranight variability is really transient in character, manifested itself with different probabilities for different galaxies.

The efficiency of the energy source for every galaxy to produce intranight variability on a given level (duty cycle of the central energy engine) was estimated using these probability curves. For a given threshold of detection estimated as an error of a given technique (for instance, 1% for observations presented in this paper), one can conclude that duty cycle of NGC 1275 is about 100%. Vice versa, NGC 4151 has a more quiet energy source: only $\sim$ 60% of nights show intranight variability on a level more than 1%. An efficiency of the energy source produces near IR radiation of NGC 7469 is more than 0.9, while at the optical bands it is equal to $\sim$0.7$\pm$0.1. It may be an indication on the presence of an independent IR energy source, too.

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New X-ray Constraints on Starburst and Seyfert Activity in the Barred Spiral Galaxy NGC 1672

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The nearby barred spiral galaxy NGC 1672 shows dramatic starburst activity and may also host a Seyfert 2 nucleus. We present new X-ray observations that set constraints on starburst and Seyfert activity in NGC 1672. to investigate long-term variability of the known X-ray sources and to search for new sources of X-ray emission. We find large-amplitude ($\approx 69\%$) variability from X-3, one of the off-nuclear sources located near an end of the galactic bar. X-3 has a peak observed 0.2–2.0 keV luminosity of $\approx 2.5 \times 10^{39}$ erg s^{-1}, and it is probably a luminous X-ray binary or young supernova remnant. We do not observe variability of the nuclear source X-1 or the strong off-nuclear source X-2. Our analyses also reveal two new off-nuclear sources, one of which is associated with a bright region along a spiral arm, and we find evidence for large-scale diffuse X-ray emission throughout part of the disk of NGC 1672.

Furthermore, we use ASCA data taken in 1995 to constrain the hard X-ray properties of NGC 1672. While the nuclear source X-1 is the dominant soft X-ray source in NGC 1672, we find that the bulk of the 2–10 keV and 5–10 keV emission is spatially coincident with the off-nuclear source X-3, giving it an apparent 0.2–8 keV luminosity of $> 6 \times 10^{39}$ erg s^{-1}. A power-law plus Raymond-Smith model provides an acceptable fit to the full-band ASCA spectra. We do not find any evidence for a luminous but absorbed nuclear X-ray source. If there is a luminous Seyfert 2 nucleus in NGC 1672, it must be obscured by a 'Compton-thick' torus with a column density of $> 2 \times 10^{24}$ cm^{-2}.

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X-ray Absorption in Radio-Quiet QSOs

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Major flows of ionized gas are thought to be present in the nuclei of most luminous QSOs, and absorption by these flows often has a significant effect upon the observed X-ray continuum from the black hole region. We briefly discuss X-ray studies of this gas and attempts to determine its geometry, dynamics, and ionization physics. Our focus is on X-ray warm absorber QSOs, Broad Absorption Line QSOs, and soft X-ray weak QSOs. We also discuss some prospects for further study with the next generation of X-ray observatories.

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Tartarus – An ASCA AGN database

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Tartarus is a database of products from *ASCA* observations of AGN. We discuss access to and products available within the database, and detail the data-reduction process.

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"Stellar Endpoints, AGN and the Diffuse Background".

The paper is available via `http://tartarus.gsfc.nasa.gov/doc/method_outline.html`

X-ray Selected BL Lacs and Blazars

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With their rapid, violent variability and broad featureless continuum emission, blazars have puzzled astronomers for over two decades. Today blazars represent the only extragalactic objects detected in high-energy gamma-rays. Their spectral energy distributions (SEDs) are characteristically double-humped, with lower-energy emission originating as synchrotron radiation in a relativistically beamed jet, and higher-energy emission due to inverse-Compton processes. This has accentuated the biases inherent in any survey to favor objects which are bright in the survey band, and should serve as a cautionary note both to those designing new surveys as well as theorists attempting to model blazar properties. The location of the synchrotron peak determines which blazar population is dominant at GeV and TeV energies. At GeV energies, low-energy peaked, high luminosity objects, which have high L_C/L_S ratios, dominate, while at TeV energies, high-energy peaked objects are all that is seen. I review the differences between low-energy peaked and high-energy peaked blazars, and models to explain those differences. I also look at efforts to bridge the gap between these classes with new surveys. Two new surveys have detected a large population of high-energy peaked emission line blazars (FSRQ), with properties somewhat different from previously known objects. This discovery has the potential to revolutionize blazar physics in a way comparable to the discovery of X-ray selected BL Lacs ten years ago by *Einstein*. I cull from the new and existing surveys a list of $z < 0.1$ high-energy peaked blazars which should be targets for new TeV telescopes. Among these are several high-energy peaked FSRQ.

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The ENLR of the Seyfert 1 ESO362-G18 *vs.* that of the Seyfert 2 ESO362-G8

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We use long-slit spectroscopic data to study in detail the ENLR's of the Seyfert 1 (Sy1) galaxy ESO362-G18 and Seyfert 2 (Sy2) galaxy ESO362-G8. In the Sy1 galaxy the high excitation gas shows an approximately cone-shaped morphology. From the observed kinematics, we conclude that the gas within the cone most probably belongs to the galaxy disk, which implies that the collimation axis is closer to the disk than half the opening angle of the cone of ionizing radiation. In the Sy2 galaxy, the main structure in the high excitation gas is an emission blob which apparently consists of a high latitude cloud being blown away from the nuclear region and ionized by the nuclear source.

The optical nuclear continuum in the Sy1 galaxy is a featureless power-law $F_\nu \propto \nu^{-0.76}$, while for the Sy2 we conclude that the nuclear bluer color and smaller equivalent widths of the absorption lines are due to an ageing burst of star formation (age $\approx$300 Myr), and that the nuclear source is hidden from direct view. We used the photoionization code MAPPINGS Ic and a mixture of matter-bounded (MB) and ionization-bounded clouds to model the ENLR's of the two galaxies. For the Sy1 ESO362-G18, the inferred luminosity of the model ionizing continuum can be reconciled with the flux observed in the optical, while in the X-rays, the model's continuum indicates the presence of an absorber. We shown that around the nucleus, the Sy1 has a higher excitation, due to a larger contribution of the MB component. However, the excitation in the Sy1 cone is lower than in the blob of the Sy2 due to a combination of a lower ionizing flux and larger gas density in the disk of the Sy1. We derive filling factors, covering factors and gas masses along the ENLR as a function of distance from the nucleus. The total ionized gas mass derived for the blob in the Sy2 is $10^{5.8}$ $M_\odot$, consistent with its proposed origin in a nuclear superwind which probably occurred $\sim$ 300 Myr ago, while the ionized gas mass in the disk of the Sy1 is one order of magnitude smaller.

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On the Reliability of Cross Correlation Function Lag Determinations in Active Galactic Nuclei

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Many AGN exhibit a highly variable luminosity. Some AGN also show a pronounced time delay between variations seen in their optical continuum and in their emission lines. In effect, the emission lines are light echoes of the continuum. This light travel–time delay provides a characteristic radius of the region producing the emission lines. The cross correlation function (CCF) is the standard tool used to measure the time lag between the continuum and line variations. For the few well-sampled AGN, the lag ranges from 1–100 days, depending upon which line is used and the luminosity of the AGN. In the best sampled AGN, NGC 5548, the Hβ lag shows year–to–year changes, ranging from about 8.7 days to about 22.9 days over a span of 8 years. In this paper it is demonstrated that, in the context of AGN variability studies, the lag estimate using the CCF is biased too low and subject to a large variance. Thus the year–to–year changes of the measured lag in NGC 5548 do not necessarily imply changes in the AGN structure. The bias and large variance are consequences of finite duration sampling and the dominance of long timescale trends in the light curves, not due to noise or irregular sampling. Lag estimates can be substantially improved by removing low frequency power from the light curves prior to computing the CCF.

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